Summer 2013 Wildlife Survey Results

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Introduction

Increasingly, ecologists are recognizing the range of benefits provided by the biodiversity found in cities (Dearborn & Kark 2010; Blaustein 2013). Because of the importance of urban biodiversity, it is vital that we gain a better understanding of which species are actually inhabiting our cities. Carnivores are particularly relevant to the study of biodiversity because of their role in structuring ecosystems (e.g. Estes et al. 1998) and because of human interest in these animals (Gittleman et al. 2001). Among the carnivores, medium-sized carnivores, or mesocarnivores, are a particularly common in urban areas (Bateman et al. 2012) and are therefore a good focal taxon for urban biodiversity research.

Urban environments are some of the most heavily impacted by humans (Ellis & Ramankutty 2008), making them prime candidates for restoration activities. The Green Seattle Partnership has developed a comprehensive plan to guide forest restoration in Seattle's greenspaces (Green Seattle Partnership 2005). To determine if restoration activities are achieving their stated goals of removing invasive species and restoring native canopy trees, the plan budgets for vegetation-based post-project monitoring. However, to determine if the restored natural areas are functioning ecosystems, we would also need to document the presence of high-trophic level species like mammalian carnivores. Consequently, monitoring for these species in a variety of restoration phases will enhance our understanding of wildlife responses to management.

Preliminary research at Seward Park using baited track plates yielded relatively few target species, with confirmed prints only from Virginia opossum (*Didelphis virginiana*) and mice (*Peromyscus sp.*). Two possible explanations for this relative lack of biodiversity stand out. The first is that Seward Park, in spite of its old growth forests, may lack some mammalian biodiversity because it sits on a relatively isolated peninsula in Lake Washington. The second is that the target species are present in Seward Park, but we were using an inappropriate bait or lure to capture tracks of these species.

During July and August 2013 we expanded this study to five additional parks in central and south Seattle of varying size, degree of isolation from other greenspaces, and restoration phase. Within these parks, we tested different bait and lure combinations at track plates and camera traps. Our primary goals were to refine a method for monitoring Seattle's urban wildlife while enhancing our understanding of the roles of forest restoration and biogeography on the biodiversity of Seattle's natural areas.

Methods

We sampled wildlife in parks and greenspaces located in central and south Seattle (Figure 1). This area was bounded to the north by the ship canal, to the south by Orcas Ave. S, to the west by I-5, and to the east by Lake Washington. We placed a total of 32 bait stations in the six largest natural areas in this region, with between 4 and 6 stations in each park (Figure 2).

Our noninvasive bait stations consisted of baited aluminum track plates designed to collect track imprints of any animal that entered the station (Barrett 1983; Ray & Zielinski 2008). The track plates were enclosed in a triangular, corrugated plastic box 12" × 32" × 10.4" (l × w × h). We placed a remotely-triggered camera trap (Reconyx, Inc., Holmen, WI, USA) at 18 of the locations with the camera facing the entrance to the track plate box. Due to logistical constraints, we were only able to place one camera in the Interlaken Park and Seward Park study areas, and we were not able to use a camera trap at Frink Park. All other stations had camera traps.

We baited each track plate station with either a frozen chicken leg or a small amount of canned tuna. Additionally, we used both visual attractants and a call lure to attract animals to the location (Schlexer 2008). The lures were constructed from an aluminum pie plate attached to a small, plastic canister by a swivel fishing lure. In each plastic canister, we placed two cotton balls soaked in one of two lures: catnip oil or fish oil. We randomly assigned both the bait and the lure to each station in a fully factorial design such that half of all stations within a study area received each type of bait and lure. We located stations far enough from trails and roads that the visual attractant was not readily visible to anyone walking by. We checked the stations twice a week for three weeks to refresh the lure and bait and to retrieve tracks and photographs.

We identified tracks and photographs to the lowest taxonomic level possible. We used standard statistical methods to compare the success of different baits and lures at capturing different species. We also compared taxonomic richness and number of detections to the restoration phase at each site.

Results

We captured a variety of mammal taxa with both track plates and camera traps, including four carnivores and one carnivorous marsupial (Table 1). Two of these carnivores were domestic animals (cats and dogs). We also captured photographs of a variety of bird species, including Steller's Jays (*Cyanocitta stelleri*), Spotted Towhees (*Pipilo maculatus*), and American Robins (*Turdus migratorius*). With the exception of the Virginia opossum, camera traps detected species at more locations than did track plates (Table 2).

Latency to first detection (LTD), or the number of nights before the first detection of a particular species, varied considerably among species and between detection methods (Figure 3). In general, track plates had a shorter LTD. Raccoons (*Procyon lotor*) had the highest average LTD, though this was highly variable. There was not a strong pattern in the distribution of LTD for each species (Figure 4), though many raccoons took >10 nights before their first camera capture (Figure 4C).

The type of bait did not have a significant impact on the number of tracks captured for any species (Table 3). Domestic cats showed a slight preference for tuna with captures on 8.1% of trap nights compared to a single occasion (1.2% of trap nights) for chicken ($p = 0.12$, Fisher's Exact Test, $N = 7$), but sample sizes were too low to draw a clear inference. Similarly, the type of lure did not have a significant impact on track captures for any species. Raccoons exhibited a slight preference for fish oil ($P = 0.12$, Fisher's Exact Test, $N = 7$), though this was also with a small sample size.

Camera captures yielded larger sample sizes and therefore offer more opportunity for making inferences about lure type (Table 3). We did not compare different baits for camera captures because cameras detected any species that approached the bait station, which was more likely affected by the type of lure than the type of bait inside the station. Neither domestic dogs nor domestic cats showed a significant preference for either lure type. Raccoons were photographed significantly more often at sites lured with fish oil ($p = 0.028$, Fisher's Exact Test, $N = 25$). Opossums were not captured frequently enough at camera traps to draw a clear inference ($N = 5$).

There was a slight increase in the number of taxa identified with camera traps following restoration, and cameras were more effective at detecting animals than track plates in terms of number of taxa and number of individual capture events (Figure 5).

Discussion

For documenting wildlife, particularly carnivores and a carnivorous marsupial, camera traps performed better than track plates (Table 1), capturing more species than track plates. However, this came with some cost of time. For many species, camera traps had a longer latency to first detection, suggesting a need to keep stations baited for at least two weeks (Figure 3, 4).

The fact that camera traps detected species at more locations and documented more species overall might suggest they are the superior detection device. However, each camera trap comes with a relatively high price tag (~$600). While there are less expensive camera traps available, they do not perform as well in a research setting because of a combination of better nighttime detection, shorter trigger speed, and faster recovery time for Reconyx cameras. Additionally, track plates are not reliant on technology and can still detect animals in cases when the camera trap malfunctions. The track plate box is also a good staging area for a hair snare for genetic analysis (Kendall & McKelvey 2008). For these reasons, a combination of device types may be advised for certain applications.

There was very little difference between bait or lure types, with raccoon preference for fish oil as a call lure the only significant result. Chicken was far easier to handle than tuna because we could bait each station with a single piece of frozen chicken, making storage, baiting, and clean-up much easier than working with small piles of canned tuna. Consequently, with the possible exception of a study targeting felines, we would recommend frozen chicken as a bait for studying urban carnivores. While the catnip oil was easier to work with because it came in a spray dispenser bottle and had a pleasant aroma, we would recommend fish oil, particularly for a study targeting raccoons. While many other lure types have been used in carnivore surveys (Schlexer 2008), we feel that the two we tested were the best options for our suite of target species.

While we captured Virginia opossums frequently at every bait station in Seward Park, they were infrequent visitors or absent at all other locations. We suspect this may be due to displacement by raccoons. A low density of raccoons would lend support to this hypothesis. However, due to logistical constraints, we did not have camera traps at all locations in Seward Park. Because cameras were far more successful at detecting raccoons, we cannot determine if this species is absent from the location with high opossum density. Future research will place more camera traps at this location to verify this apparent example of competitive exclusion.

We did not detect any strong impact of restoration phase on biodiversity. There are at least two possible explanations for this result. The first explanation is that the time since restoration for many of these sites has been relatively short (<5 years). Consequently, much of the understory and mid-level vegetation has yet to fill in following removal of English ivy (*Hedera helix*) ground cover. The second explanation for the lack of significant results for restoration phase is that the species we detected are generalists that do well in highly modified environments. These species were present across the range of restoration phases and many can be detected readily in adjacent residential neighborhoods. However, more detailed analysis such as an occupancy modeling approach might detect subtle differences in detectability or occupancy among the restoration phases that would suggest altered ecological relationships among this guild of species (MacKenzie et al. 2006; Royle & Kéry 2007). Additionally, other taxa, such as ground-nesting birds, may be responding much differently to the restoration process, so studies of these taxa may yield different results.

The biogeographic analysis is ongoing, and we do not have results to report at this time.

Conclusions and Future Directions

Based on our results, we have determined that camera traps using a fish oil lure are the optimal noninvasive monitoring device for our target species. However, we do not have enough resources to place camera traps at all locations we wish to monitor. Therefore, we will use a sample unit similar to that developed by Zielinski et al. (1995), which will include a mix of track plates baited with chicken and a single camera station grouped in a small area. We will also incorporate a hair snare into the track plate box with the goal of collecting hair from raccoons for genetic analysis. We will also expand the study to include parts of West Seattle to evaluate the Duwamish Waterway as a barrier to movement.

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Tables and Figures

Table 1. Mammal species detected with track plates or camera traps in six urban parks, Seattle, WA, USA during July and August 2013.

Species		Track plate	Camera
Didelphimorphia			
Didelphidae			
Virginia opossum	*Didelphis virginiana*	X	X
Rodentia			
Sciuridae			
Squirrels[1]		X	X
Muridae			
Rat	*Rattus sp.*		X
Carnivora			
Canidae			
Coyote	*Canis latrans*		X
Domestic dog	*Canis familiaris*	X	X
Procyonidae			
Raccoon	*Procyon lotor*	X	X
Felidae			
Domestic cat	*Felis catus*	X	X
Artiodactyla			
Cervidae			
Mule deer	*Odocoileus hemionus*		X

1. All unidentified Sciuridae

Table 2. Percentage of bait stations that detected the six most frequently detected mammal species for track plates and camera traps in six urban parks, Seattle, WA, USA during July and August 2013.

Species	Track plate detection	Camera detection
Virginia opossum	21.9	5.6
Squirrels[1]	15.6	44.4
Rats[2]	0	38.9
Domestic dog	3.1	27.8
Raccoon	15.6	66.7
Domestic cat	12.5	33.3

1. All unidentified Sciuridae

2. All unidentified *Rattus spp*.

Table 3. Track plate and camera trap results for bait stations in six urban parks, Seattle, WA, USA during July and August 2013. Capture is the total count of captures at each combination of device, bait, and lure. If more than one animal was captured in a given trap night, those were recorded as separate captures. Capture rate is the percentage of active trap nights that a capture occurred at a track plate (N = 136 trap nights for each combination of bait and lure) or camera trap (N = 136 trap nights for catnip oil and N = 170 trap nights for fish oil).

Device	Bait	Lure	Captures	Capture rate
Track plate	Chicken	Catnip oil	9	3.3
		Fish oil	16	5.9
	Tuna	Catnip oil	15	5.5
		Fish oil	13	4.8
Camera trap	Either	Catnip oil	89	65.4
		Fish oil	123	72.4

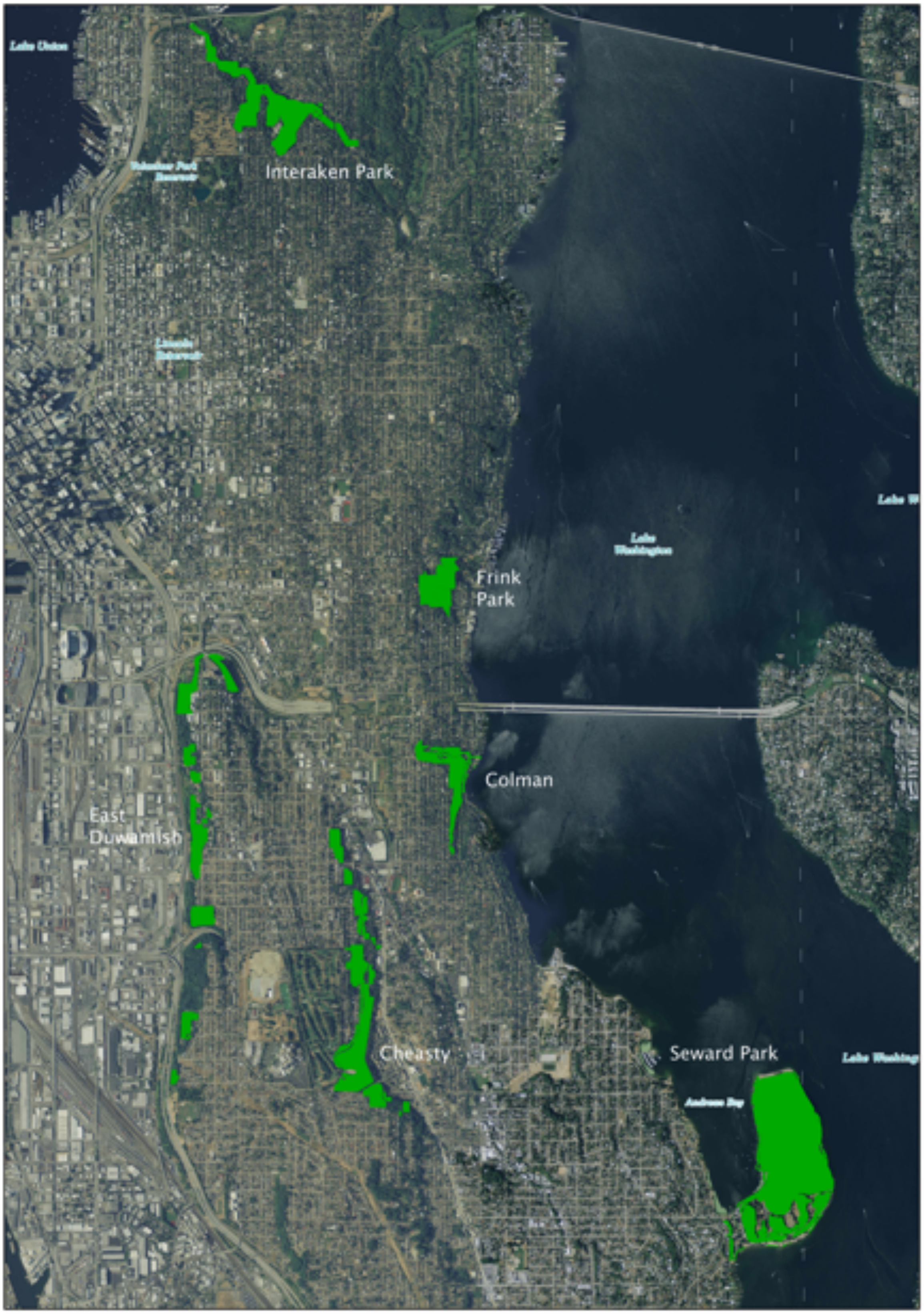


Figure 1. Satellite map of central and south Seattle showing six study areas sampled for mammals during July and August 2013.

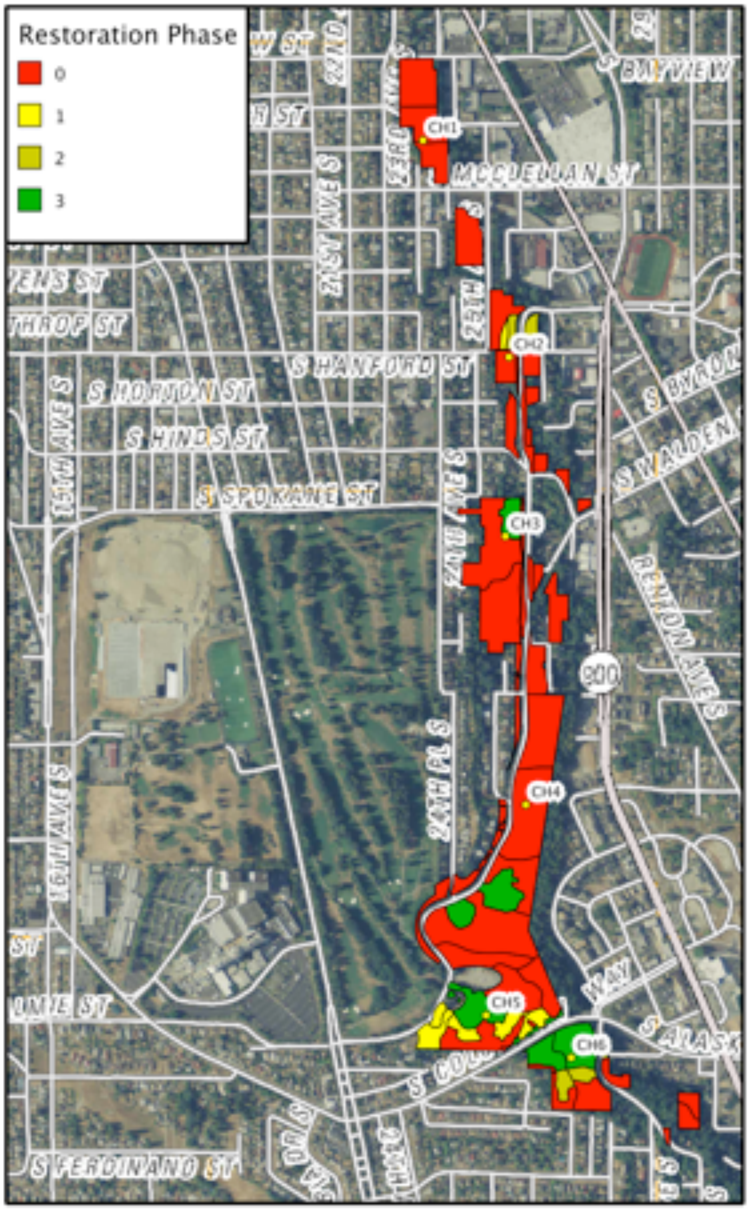


Figure 2. Detail map of Cheasty study area showing the location of each bait station, labeled CH1-CH6. Restoration phases are from Green Seattle Partnership classification in 2009 and are based on the following criteria: Phase 0 = no restoration, Phase 1 = invasive removal, Phase 2 = secondary invasive removal and planting, and Phase 3 = plant establishment (Green Seattle Partnership 2005).

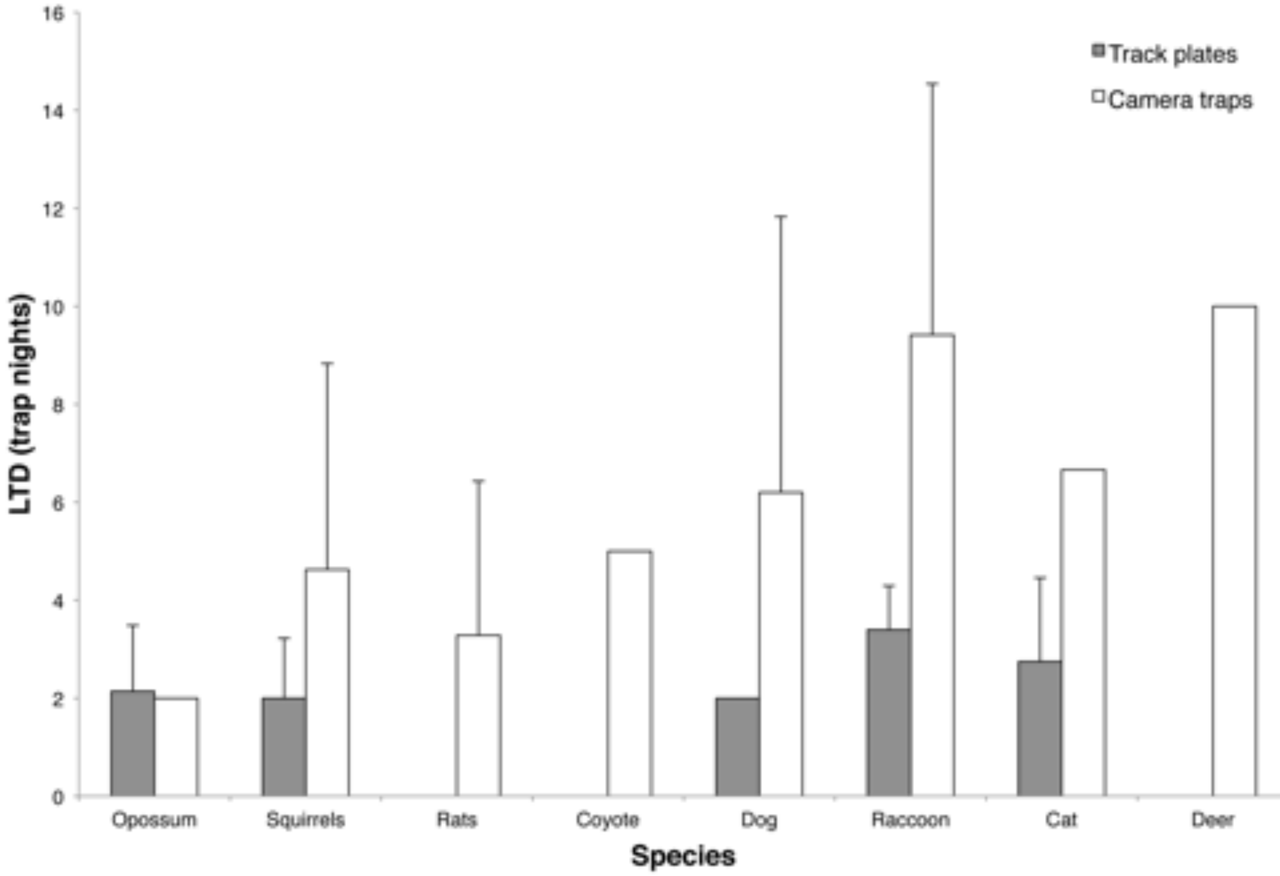


Figure 3. Mean latency to detection (LTD) for each species by track plates and camera traps in six urban parks, Seattle, WA, USA during July and August 2013. LTD is in number of survey nights since the station was first baited ± SD. LTD values do not include stations that did not capture the species.

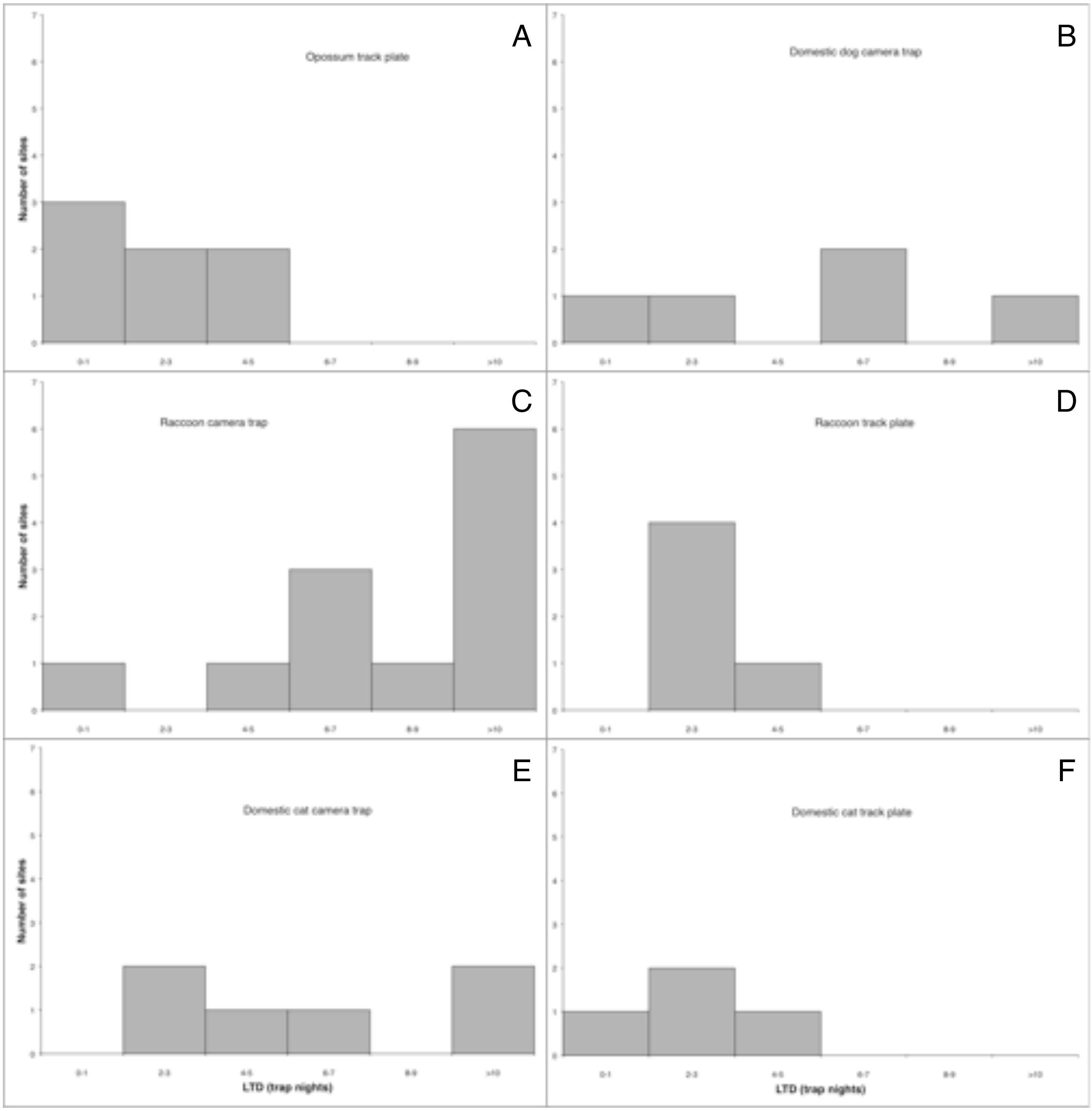
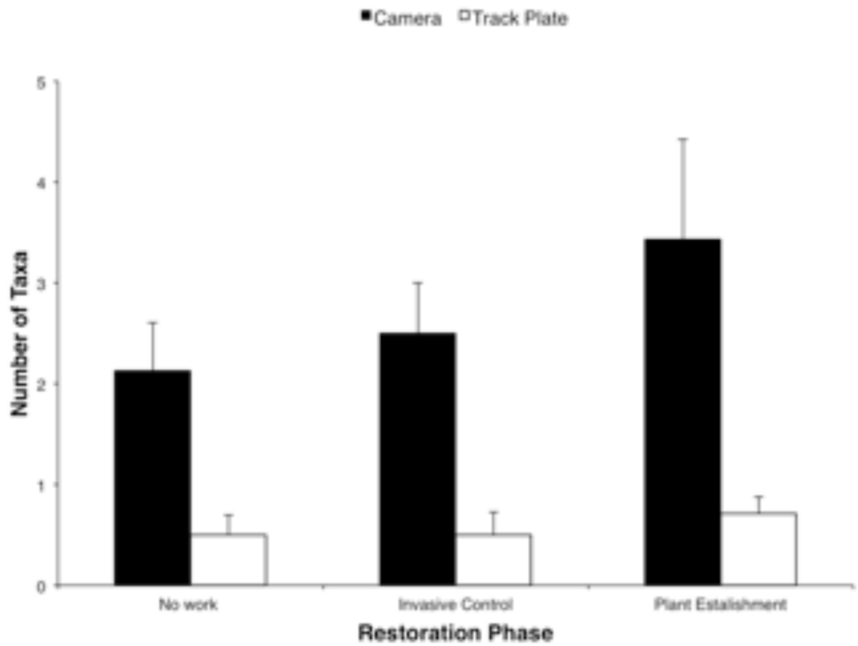


Figure 4. Histograms of latency to detection (LTD) for selected species detected at track plates and camera traps in six urban parks, Seattle, WA, USA in July and August 2013.



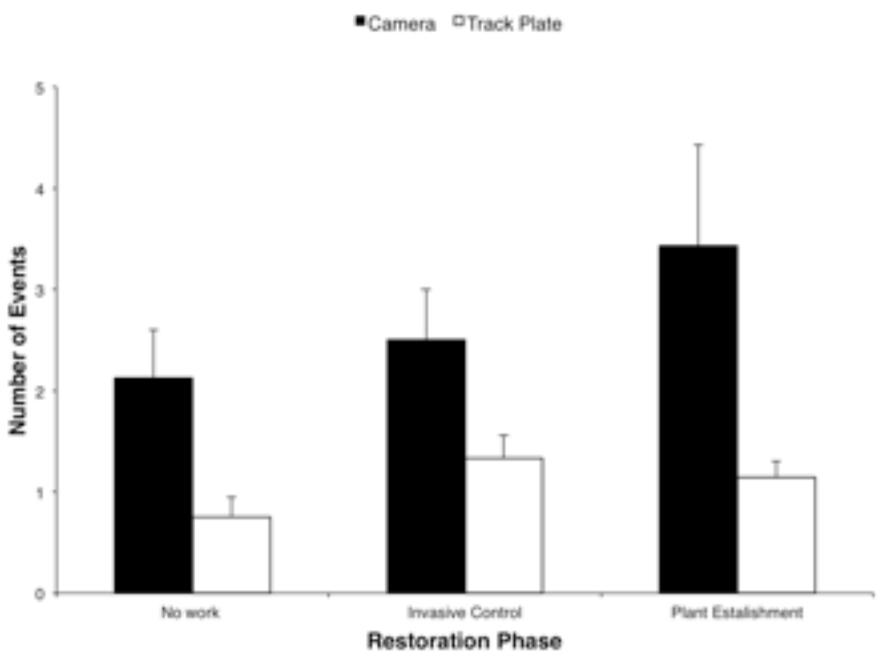


Figure 5. Mean ± SD of number of taxa and number of capture events for track plates and camera traps in sites in three different phases of restoration. Surveys were conducted in six urban parks, Seattle, WA, USA in July and August 2013. Restoration phases are described Green Seattle Partnership (2005). The number of taxa captured by camera slightly increased with restoration, though this increase was not significant (one-way ANOVA, P = 0.52). There was no difference in taxa captured by track plates (one-way ANOVA, P = 0.64). Sites in the invasive control phase had the greatest number of camera captures, although this relationship is not significant (one-way ANOVA, *P = 0.60). There was also no relationship between restoration phase and track plate captures (one-way ANOVA, P = 0.72).